

Application of Modern Polymer Packaging for Food

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ABSTRACT

The object of the study is a polymer combined C-PET packaging two-section, which consists of a polymer semi-rigid container-tray of multilayer PET / EVOH / CPP and multilayer polyethylene film S900775 PET / PE (for sealing containers). In the food industry can be used consumer polymer packaging of various types: hard, semi-hard, soft and others. In order for such packaging to be used for heat sterilization of products, it must have the necessary heat-resistant barrier layer. C-PET packaging is made of heat-resistant barrier material, which ensures its resistance to high temperatures. Therefore, such containers can be used for heat sterilization and guarantee long shelf life of food. Each polymeric material has certain indicators of heat resistance.

One of the most problematic places on this issue is the lack of technological parameters of polymer C-PET packaging, such as the strength of the sealing of the package and the parameters of sterilization of packaging with the product for specific thermal equipment: temperature, time, back pressure. Without the values of such characteristics, it is impossible to use containers in food production to produce good quality products for long-term storage.

The study used methods such as measuring the sealing strength or depressurization pressure of the container, which occurs during sterilization due to thermal expansion of the product; the standard membrane compensation method was used for this purpose. The development of sterilization regimes for food products was carried out in accordance with the approved regulations. The regulations include analytical calculation of the regime that ensures the production of industrially sterile canned food, laboratory testing of the selected regime and its production testing. Methods of calculating the sterilization regime are based on data on the heat resistance of the strain of microorganisms in the test culture.

Studies have been carried out, which resulted in the value of the parameter of sealing strength or depressurization pressure of C-PET containers, without which it is impossible to carry out effective thermal sterilization of the product. Exceeding the required value of this pressure can lead to depressurization of the packaging and the emergence of physical defects, of substandard products. Also, scientifically based high-temperature sterilization regimes for meat and vegetable products in the studied form of polymer consumer packaging have been developed, which will allow companies to produce quality food safe for consumption, with high nutritional value and long shelf life.

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Introduction

Food packaging is a specific type of packaging that requires particularly careful selection of material, production methods, processing methods and storage conditions. Food packaging must be safe, attractive, durable and inexpensive. Polymeric packaging for food products, depending on the materials used, mechanical stability and degree of strength are divided into hard, semi-rigid and soft.

For example, semi-rigid packaging includes: containers such as cups, jars, single- and multi-section pallets made of polypropylene, polyvinyl chloride, impact-resistant polystyrene, a number of copolymers and coextrudates. This type of packaging is made of

multilayer polymeric materials with high barrier properties, such as PET / EVOH / CPP (polyethylene terephthalate / copolymer of ethylene vinyl alcohol / oriented polypropylene), which are used for food sterilization. Semi-rigid packaging also includes a combined cardboard packaging with a polymer coating and aluminum foil as a barrier layer. This group, varying in size and shape of the container, includes a number of designs such as “Tetra Pak”, “Tetra Brick”, “Combibloc” and others [1-4].

Polyethylene terephthalate (PET), polyethylene, polypropylene, polynamide-11 and other heat-resistant polymeric materials are used for the production of canned food, the preservation of which must be ensured by heat sterilization. The sterilization process is complicated by back pressure regimes in the equipment to compensate for excess pressure in the container with the product, which occurs due to thermal expansion of the product. The

pressure in the device during the whole cycle should slightly exceed the pressure in the container, preventing the inflation of the packages [5-7]. The usual PET packaging can withstand low packaging temperatures of 70-75oC, if the temperature is higher, then there is an irreversible deformation of the container. Barrier copolymers PET Polyclear 2201 and PET / PEN Polyclear 2202 are used for the production of heat-resistant PET packaging. In both cases, the heat resistance of the material is higher than that of simple PET. Brands 2201 and 2202 can withstand up to 1980oF (920oC), which far exceeds the usual range of such methods of heat treatment of food products as “hot bottling”, pasteurization and high-temperature sterilization [8-9].

A striking example of soft polymer packaging for food packaging are packages of the type “doy-pack” (doy-pack, pouch), made of combined polymeric materials. At the bottom of the package there is a fold, which when filling the container with the product spreads, forming a bottom that allows the package to stand. Doy-pack packages are used for packing liquid, pasty, liquid products (sauces, ketchups, purees, juices), for baby food products with a long shelf life.

Interesting and promising is the soft polymer packaging “retort packages”, made of special multilayer films, which must be neutral in their properties to food, heat-sealed, non-shrinking and heat-resistant at temperatures above 100oC for the time required for sterilization. Retort packaging is a rectangular flexible laminated package made of polymeric materials (aluminum foil laminated with layers of polymeric materials (laminates) based on polymer films without the use of foil) with four hermetically sealed seams, in which the food can be heat treated. “Retort packages” are made of 2-4 layers of laminated film with a thickness of 80-160 μm. Manufacturers are looking to replace aluminum foil with more technological and cheaper barrier materials, such as EVOH or multilayer barrier film consisting of PET / Al / Bonyl / PP, PP / Bonyl / CPP (PET polyethylene terephthalate, Al-aluminum foil, Bonyl Dupont, PP-polypropylene, CPP-oriented polypropylene). This composition of the material allows you to immerse such containers in an autoclave with a temperature of 120-130oC for 30-60 minutes. This is a light, high-quality, durable, easy-to-use package that packs food (first and second canned meals, animal feed, etc.) with a long shelf life of up to 2 years [8-10].

When using modern types of polymer containers for sterilization of food, it is necessary to take into account the technological features of this packaging, such as sealing strength or depressurization pressure, as well as temperature, time, pressure during heat treatment in the equipment. These characteristics depend on the type of container, the method of its closure, the packaging temperature of the product and other factors. When using such packaging made of heat-resistant barrier materials, these characteristics are of great importance, because knowing their values can prevent physical shortages of food and effectively carry out the process of thermal sterilization. Therefore, these studies are relevant [11].

The object of research is a two-section polymer C-PET container, which consists of a polymer semi-rigid tray made of heat-resistant multilayer PET / EVOH / CPP and multilayer polyethylene film S900775 PET / PE (for sealing containers). Packaging capacity - 350 g. The type of packaging is shown in fig. 1.



Figure 1: Polymeric Container Type C-PET Two-Section

The novelty of the research is that the technological parameters, sterilization modes for the range of products packed in C-PET containers for specific thermal equipment have been developed.

Research Objectives

Determination of the parameter of sealing strength or depressurization pressure for two-section C-PET containers; conducting thermos physical research to study the heating of food products and the development of sterilization regimes for canned food “Ukrainian Borsch”, “Porridge with meat”, in the form of polymer containers for the vertical autoclave B6-KAV-2 under study.

Methods of Research

The research was conducted in the laboratory of food sterilization of Odessa National Technological University. A standard membrane compensation method was used to measure the sealing strength of a container or the depressurization pressure of a package that results from sterilization due to thermal expansion of the product. Capillary containers are connected to the compressor and the diaphragm unit of the compensation line. Using a compressor that supplies air to the receiver and then to the container, an excess pressure is created, which was measured using a membrane unit attached to the package. The value of the sealing strength of the container was determined using a manometer. Measurements were made after 0.01 MPa. After the maximum deflection of the center of the lid and maintaining the tightness of the container, the internal pressure was reduced to 0.1 MPa and the presence or absence of residual deformation of the film was determined by the indicator. The experiment was performed under normal conditions (ambient temperature 18-20oC and atmospheric pressure 0.1 MPa). This assumption is possible because within the operating temperatures of the process of technological processing, the mechanical properties of the container do not change [12].

The schematic diagram of the research stand is shown in fig. 2.

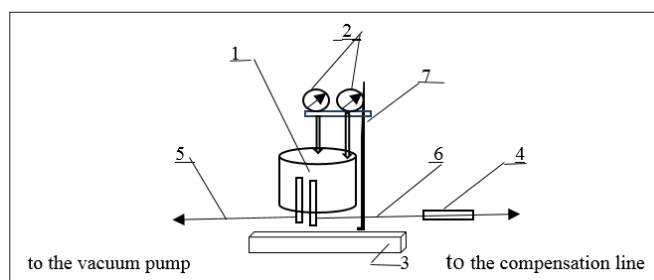


Figure 2: Scheme of the Stand for Studying the Strength of the Closure and Deflection of the Center of the Packaging Film

1-Tare; 2- Indicator; 3- Calibration Plate; 4-Membrane Block; 5-Capillary Air Duct; 6-Capillary to the Membrane Block; 7-Container Clamp

The development of canned sterilization regimes was performed in accordance with the requirements of the current instructions. Execution of works in accordance with the instructions includes analytical calculation of the regime that ensures the production of industrially sterile canned food, laboratory testing of the selected regime and its production inspection. For the analytical calculation of sterilization modes, the change in product temperature during sterilization is taken into account. For practical application, there is a method of calculation based on an analytical comparison of the equivalence of the required lethality with the actual for this mode of sterilization at the point of the product, which is the least heated during heat treatment of food. Any of the methods of calculation of the regime is based on data on the heat resistance of the strain of microorganisms of the test culture, which should guarantee the industrial sterility of canned food. Sterilization regimes were developed for food products “Ukrainian Borsch”, “Meat Porridge” in a polymer C-PET container in a vertical autoclave B6-KAV-2 [11-14].

Results of Research and Discussion

The results of studies of polymer heat-resistant two-section C-PET packaging, which is sealed with a polyethylene heat-resistant film, showed that the parameter of sealing strength or critical overpressure is 0.04 MPa. When the pressure in the container reaches more than 0.04 MPa, each section of the package is depressurized. Therefore, when heat sterilizing products in C-PET containers, the cooling mode must be calculated so that the pressure drop in the apparatus and inside the product package does not exceed this experimental value, otherwise the package will be depressurized, ie physical shortage of products. Thus, the maximum pressure in the two sections of the C-PET container with the product during sterilization should not exceed 0.04 MPa.

Modes of heat treatment of food products “Borsch” Ukrainian “;” Porridge with meat “in the autoclave B6-KAV-2 were also developed, the product is packed in a two-section container type C-PET, which is sealed with a polymer film with a capacity of 350 g. are presented in table 1.

Table 1: Parameters of the process of sterilization of products “Ukrainian Borsch”, “Porridge with meat” in the autoclave B6-KAV-2 using a two-section polymer container type C-PET

| Time, min | The temperature of the water in the autoclave, °C | Autoclave pressure, MPa |
|-----------|---|-------------------------|
| 0 | 40 | 0 |
| 5 | 70 | 0,01 |
| 10 | 80 | 0,02 |
| 15 | 90 | 0,03 |
| 20 | 100 | 0,04 |
| 25 | 120 | 0,05 |
| 30 | 120 | 0,05 |
| 35 | | |
| 40 | | |
| 45 | | |
| 50 | | |
| 55 | | |
| 60 | | |
| 65 | | |
| 70 | | |
| 75 | | |
| 80 | 100 | 0,04 |
| 85 | | |
| 90 | 80 | 0,035 |
| 95 | 60 | 0,03 |
| 100 | 50 | 0,02 |
| 105 | 40 | 0,01 |
| 110 | | |

$\frac{25-60-25}{(120 \pm 1) \text{ } ^\circ\text{C}}$ (pressure according to the table 1, MPa)

The peculiarity of the development and calculation of this sterilization regime is that the products “Ukrainian Borsch”, “Porridge with meat” are sterilized at the same time, but they have different mortality, which ensures industrial sterility of canned food. With meat “. This is due to the different rate of heating of the product due to its different consistency. Liquid products heat up faster than thicker.

Conclusion

When using the investigated type of polymeric C-PET container for sterilization of food products, it is necessary to maintain in the equipment the difference between the pressure in the device and the pressure in the container with the product at least 0.05 MPa at all stages of heat treatment. Under these conditions, the plastic lid-film is in the unloaded state, which is necessary to prevent depressurization of the container and cause physical shortages. This will ensure the integrity and tightness of the package with the contents. Developed scientifically sound sterilization regime for the range of “Borsch” Ukrainian “,” Porridge with meat “in C-PET packaging, will allow to obtain industrial sterile products for long-term storage, ie canned food.

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